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A STUDY OF THE MAGNETIC EVOLUTION OF ACTIVE REGIONS AND
ITS RELATION TO SOLAR FLARES(U) CALIFORNIA STATE UNIV
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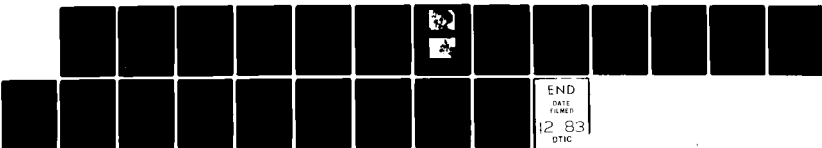
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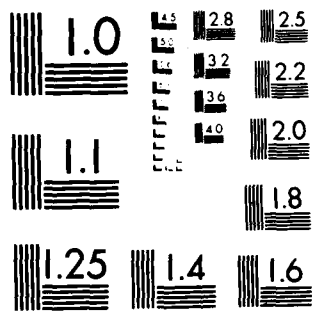
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A STUDY OF THE MAGNETIC EVOLUTION OF
ACTIVE REGIONS AND ITS RELATION TO
SOLAR FLARES

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18111 Nordhoff Street
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Final Report
21 April 1981 - 20 July 1982

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I. General

The purpose of this project was to obtain considerable data on solar active regions in order to gain insight into solar flares and their possible prediction. The data are time lapse filtergrams in the Mg I b-line at 5172\AA and occasional magnetograms. The Mg filtergrams are to determine the position and motion of magnetic flux tubes and sunspots, while the magnetograms help to determine the polarity of the magnetic fields.

The observing program began with some degree of regularity on 6 June 1981, with test runs beginning on 6 May. The final filter tuning was accomplished on 19 June 1981. Observations continued for the entire useable day on as many days as weather and equipment would allow. Observations with the MES (magnesium Etalon System) terminated on 15 September due in part to low film reserves. After this date all data were magnetograms, the whole observing program terminating on 16 October 1981.

II. Equipment

Magnetograms are obtained at the San Fernando Observatory using a spectroheliograph and 70mm film. Diode arrays are currently being developed. The polarized spectroheliograms are obtained in the blue wing of the 6302.5\AA line of iron ($g = 2.5$). Opposite polarizations are recorded simultaneously with a bandpass of 60mÅ. The slits have an equivalent width, with the 61cm telescope, of one arc-sec. Nearly all magnetograms were obtained with the 61cm telescope. For good seeing, the spatial resolution is approximately 2-3 arc-sec with a magnetic sensitivity of approximately 1×10^{18} maxwells (1×10^{10} wb). The first or last few magnetograms were obtained with alternating orientation of the quarter-wave plate so as to switch the sense of polarization between the two optical channels of the spectroheliograph (SHG). This switch enables an improvement in magnetic signal and the elimination of polarization biases in the SHG.

Filtergrams with MES were usually obtained with the 61cm telescope. However, if the active region being monitored was quite large or if the seeing conditions were poor, the 28cm telescope was used. Exposure times with the 61cm telescope were usually 1/15 sec. Both telescopes are F/20 but because of the larger back focal distance of the 28cm telescope, and two extra flat mirrors, its image has about 17% less intensity, necessitating slightly longer exposure times. The bandpass of the MES is set by its 0.5\AA FWHM solid fused silica etalon and an F/60 telecentric beam. The etalon bandpass is narrowed and split into a red and blue component each with a bandpass of approximately 0.4\AA corresponding to the inner damping wing of the $\lambda 5172\text{\AA}$ line. Tuning is accomplished by tilting the etalon and choosing the appropriate etalon order by tilting the 8\AA , three-period blocker.

Film used in the SHG is SO-392 and that used in the MES is SO-115. Exposed film is processed in a Fulton continuous processor in D-19. This same processor is used also for 35mm re-registered cine copies of the original 70mm film.

Magnetograms are produced either by analog subtraction, using an intermediate $\gamma = 1$ positive, or, for more quantitative work, by digital subtraction in the San Fernando Observatory digital image system. In the latter case, the 70mm originals and the calibration frame are digitized to 8-bit precision using an Optronics film scanner operating at 25 μm (0.42 arc-sec) spacing.

III. Results

A summary of the data obtained is presented in table 1. During the summer of 1981 our first flares were discovered in the $\text{Mg } 5172\text{\AA}$ line. This development was unexpected and our attention has been drawn toward these particular flares in an effort to understand how they were different from flares that showed only $\text{H}\alpha$. The Mg I flares are given in table 2, 8 flares on 4 separate days.

A photograph of the 27 July 81 flare is shown as Figure 1. A common characteristic of all Mg flares is that they occur over or near sunspots which are regions

of high fields. They can also appear in regions of high field gradients as shown especially by flares on 25 June and 26 July 1981.

Figure 2 shows magnetic field contours superimposed on a photograph of the Mg flare of 27 July 1981. The conclusions drawn from comparisons of flare and magnetic field morphology are that (a) the Mg flares occur in regions with high magnetic gradients and mixed polarity, and (b) the flares occur over areas having a high magnetic gradient but not over a unipolar concentration of flux, ie. the Mg flare appears to be more likely associated with the top of a small, low-lying loop of length typically 10-20Mm, rather than at the magnetic footpoints of larger 100Mm loops. These conclusions must be further checked because the magnetograms were obtained from one to several hours away from the time of the flare. Some indication of the motions of the magnetic elements can be obtained from the Mg images themselves since the photospheric network, known to be associated with magnetic fields, can be seen on the time lapse Mg images. These films will be turned into time lapse 16mm movies as time permits. Also enlargements of Mg frames before and after the flare will be analyzed to determine the positions of magnetic elements at the time of the flare.

Without exception, the Mg flares correspond in time to sharp spikes in 10.7 cm radio flux (Ottawa). The agreement in time of 1 to 2 minutes is within the uncertainty caused by our time interval of 1 minute. However, the peak 10 cm flux is uncorrelated with a subjective Mg importance scale ($r = 0.18$, $P > 0.5$). The Mg flare importance was determined by estimating the area and intensity of the Mg emission on a scale 0.5 to ten, with ten corresponding to the 27 July 81 flare.

We find the Mg flare importance is correlated with both the GOES, 1-8Å flux ($r = 0.81$, $P < 0.005$) and an X-ray "hardness" index formed from the ratio of the 0.5-4Å flux divided by the 1-8Å flux from GOES. The Mg importance is correlated with hardness index with a correlation coefficient $r = 0.65$ ($P < 0.05$).

It seems clear that the Mg I line emission is associated with an impulsive event. The H α flare importance (Solar-Geophysical Data) does not appear to be well correlated with Mg flare importance.

From a visit to Caltech, we have found that He D $_3$ emission has similarities in time and shape to the Mg flare emission. This relationship will be explored when we are able to obtain film or paper copies of Big Bear data.

An obvious use of monitoring emission in Mg I or any similar metallic absorption line is its possible sensitivity to impulsive events with a hard x-ray spectrum. Mg I could be superior to either H α or He D $_3$ in this regard since the former responds to a variety of flares whereas the latter is normally in absorption (weakly) and thus parts of the flare could have a negative contrast, other parts a positive contrast, and still others no contrast at all. Complete mapping of the flare is especially important in finding all of the footpoints of magnetic field lines involved in the flare.

Flares seen in a 3835 Å filter (Chapman, 1970; Zirin, 1980) were of a "blue continuum" type (Neidig, 1982). However, the 9 July 1978 flare of Zirin (1980) corresponded to a radio flux peak of over 2000 SFU at 9.4 GHz. None of the flares reported here had such a high radio flux.

Zirin and Neidig (1981) found that blue continuum events followed the hard X-ray data from GOES.

The size of the knots of Mg I emission is typically about 4 to 6 arc-sec. In some cases the initial brightening is at or near the resolution limit set by seeing. On 25 June this limit was about 1 arc-sec, but on 27 July the seeing appears to be more often near 3 arc-sec. Observations on 27 July were delayed by fog and low clouds.

The duration of the Mg I emission is about 7 minutes, determined from brightening and decay of flare knots on 27 July and 30 July 1981. A more accurate lifetime will have to await detailed photometry, to be carried out in the near future.

IV. Future Work

An important question to be answered by future work is where in the magnetic field these Mg I flares first show up. The answer will require the very highest resolution magnetic field maps, approaching 1 or 2 arc-sec.

Another question is what other lines or wavelengths may be involved in these Mg I flares. Further observations will be required to answer this question since the multi-band patrol telescope at Sac Peak was not operating at the times of these flares. Further work with the staff of Big Bear Solar Observatory will help with some wavelengths, for example He D₃ and H α . Two of the Mg I flares are closely associated in position and possibly shape with so called magnetic transients at BBSO. Further study may help decide the reality of these changes seen in their videomagnetograms.

V. References

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Table 1

Summary of MgI (5172Å)
Filtergrams and Magnetograms for 1981

Date		Type of Data	Time (UTC)	Comments
May	6	MES	19:35-22:37	28 cm telescope
	7	MES		Film, no log available
	8	MES	19:07-20:50	
		MES	22:46-23:59	
	9	MES	20:24-00:37	Logs but no film
	11	MES	17:25-	28cm, no film available
	17	MES	19:20-23:06	28cm, no film available
	21	MES		Log not available but there is film
	22	MES		Film, no log available
	30	SHG	20:17-20:23	
June	1	MES		Film, log not available
	3	MES		Log not available
	4	MES		Log not available
	5	MES		Log not available
	6	MES	18:28-19:30	
		MES	19:41-19:57	
		SHG	21:54-22:52	
		MES	23:23-23:45	
	8	MES		Log not available
	9	SHG	20:46-21:22	
		MES		Log not available
		SHG	22:48-23:19	
	10	MES		Logs not available
		SHG	18:40-18:50	
		SHG	23:30-00:15	
	11	SHG	21:48-22:21	

* channels

Date	Type of Data	Time (UTC)	Comments
June	16	MES	18:44-20:05
		SHG	21:52-22:27
		MES	22:51-23:09
		MES	23:46-00:28
		MES	01:04-01:18
	17	MES	18:11-19:39
		MES	19:49-22:10
		MES	22:15-23:00
		SHG	00:05-00:37
	18	MES	15:15-16:01
		MES	17:52-20:17
		MES	21:24-23:28
	19	MES	47:36-18:51
		MES	18:57-19:59
		SHG	21:15-22:01
		MES	22:43-22:50
		MES	23:33-01:07
	20	MES	15:40-17:24
		MES	17:30-17:31
		MES	17:34-18:56
		SHG	20:00-22:05
	21	MES	17:13-18:45
		MES	18:56-20:09
		MES	21:11-21:43
	22	MES	16:28-18:46
		MES	18:52-20:53
		SHG	22:15-23:57
	23	MES	15:58-16:42
		MES	16:44-18:14
		SHG	18:45-21:31
		SHG	22:46-23:25
	24	MES	16:07-17:04
		MES	17:07-19:18
		MES	19:21-19:40
		SHG	20:15-23:30

*NFA = No Film Advance

Date	Type of Data	Time (UTC)	Comments	
June	25	MES	15:58-17:07	Frames 418 & 419 removed from outer *Ch. All Inner Ch. fogged.
		MES	17:09-19:46	
		MES	19:49-22:25	
		SHG	23:00-23:43	
	26	SHG	15:29-19:40	Outer Ch-some frames blank or incomplete. Inner Ch-many incomplete, most chewed up or fogged.
		SHG	20:22-01:03	Many frames washed out by clouds some processing damage on Inner Ch.
	27	SHG	17:18-20:17	Many double exp., some fogging, processor damage.
		MES	20:40-21:16	Most frames washed out by clouds
		SHG	21:55-00:56	
	28	MES	17:23-17:52	Inner Ch. most frames scratched in processing.
		SHG	18:20-22:33	
	29	MES	16:41-17:17	Shutter sticking, NFA's - meaning possible blanks or double exp's.
SHG		17:38-19:38	Processing damage to most inner Ch. frames	
SHG		20:56-23:07	First few frames present. Most inner Ch. frames scratched in processing.	
30	MES	15:52-17:00	System shut down had to reset. Inner Ch. appears to be off line. Later frames fogged. Outer Ch. Last frame 0906. Inner Ch. - some blank. Last frame 0917.	
	SHG	17:12-17:24		
	SHG	17:49-19:41		
July	1	MES	16:45-17:42	Outer Ch - frames 1016-1027 fogged. Many frames scratched in processing Inner Ch - Later frames become thin
		SHG	18:04-21:17	
		SHG	22:02-01:27	
2	MES	16:13-16:35	Inner Ch - some partially to completely fogged. Off Line after #1088 Outer Ch - 1st frame 1066 + all above	
	MES	16:38-17:05		
	SHG	17:38-01:24		

*Ch = optical channel of spectroheliograph

Date	Type of Data	Time (UTC)	Comments
July 3	MES	17:26-19:04	
	SHG	19:34-19:43	Vacuum lost- camera opened for repair.
	SHG	20:39-20:54	same as above
	SHG	21:16-23:44	
4	SHG	16:04-16:09	SHG problems this day #1330 blank
	MES	16:32-17:21	
	SHG	19:05-22:16	same frames may be thin due to clouds. Some blanks.
	SHG	23:02-00:03	No calibr.
5	SHG	16:19-17:12	Both Ch; later frames become slightly thinner.
	MES	17:42-19:00	
	SHG	19:36-01:16	Several blanks and later frames are are much thinner.
6	MES	16:40-17:14	
	MES	17:18-18:00	Film plane covered, all frames blank this hr.
	MES	18:04-19:21	
	MES	19:26-20:45	
	MES	20:59-21:13	Film plane covered all frames blank.
	SHG	22:16-23:45	
7	MES	16:10-17:28	
	MES	17:33-19:26	New group on West limb
	MES	19:32-19:51	
	SHG	20:30-20:35	4 frames, no calibr. camera formed
	MES	21:55-22:47	Back to 1st group
	MES	22:56-01:07	
8	MES	16:16-18:03	Main group from 7 July
	MES	18:11-19:48	Group on SE Limb
9	MES	16:15-17:37	
	MES	17:56-18:56	Switch to new region in SW
	SHG	19:33-20:57	No calibration
	MES	21:08-22:41	
	MES	22:45-23:57	
10	MES	15:57-17:37	
	MES	17:45-19:45	Region switched to NE
	MES	21:31-23:46	
	MES	23:51-00:53	

Date	Type of Data	Time (UTC)	Comments
July 11	MES	16:14-17:18	
	MES	17:29-17:30	
	MES	19:05-20:04	
	SHG	20:44-21:42	
	MES	21:54-23:17	
	MES	23:24-00:46	
12	MES	16:04-16:45	Though 1st frame occurred prior to 16:45
	MES	17:02-19:32	
	MES	19:36-19:48	
	SHG	20:37-21:52	All frames very thin, not complete scans.
17	SHG	17:16-17:35	Frame 1946 limit override
	SHG	19:46-22:52	Outer Ch - Last frame # 1988
	SHG	23:21-23:30	Inner Ch. - Last frame #1990
19	MES	16:10-17:12	
	MES	17:17-18:33	
	MES	18:38-19:39	
	SHG	20:28-21:10	Frames 2032 to 2033 removed
	MES	21:54-23:45	
	MES	00:02-00:58	
	MES	01:01-01:22	
20	MES	15:42-17:13	Some NFA, slight guider drift to the east.
	MES	17:20-19:31	
	SHG	20:13-21:04	Frames 2070, 2071 + 2072 removed
	MES	21:25-22:55	
	MES	23:00-00:29	
	MES	00:34-01:09	
21	MES	15:45-16:18	Cloudy day; some frames thin
	MES	16:55-18:11	
	MES	18:14-19:39	
	SHG	20:41-21:50	
	MES	22:47-23:50	
	MES	23:58-01:03	
22	MES	15:43-17:16	Several double & mult. exposures in MES this day.
	MES	17:26-18:30	
	MES	18:34-18:58	
	SHG	19:51-20:50	All frames are off line on this day

Date	Type of Data	Time (UTC)	Comments
July 22	MES	21:05-21:10	MES now on large group in SE
	MES	21:27-22:46	Now operating with 28cm. Groups in SE.
	MES	22:52-00:00	Image drifted out of field due to guider failure
23	MES	15:57-16:39	Some double exp. this day
	MES	17:01-18:08	
	MES	18:13-19:07	Now on SE Group
	SHG	19:44-20:49	
	MES	21:15-22:17	
	MES	22:21-23:20	
	MES	23:23-00:17	
	MES	00:24-00:59	
24	MES	16:27-19:44	
25	MES	23:06-23:24	
26	MES	16:05-17:35	Group in SE with 28cm
	MES	17:50-19:32	Change to 61cm
	SHG	20:19-21:01	Flare reported in this region at
	MES	21:10-22:30	
	MES	22:34-23:26	Group in SW. Group in NW near limb.
	MES	23:31-00:06	
	MES	00:10-00:15	
	MES	00:19-00:23	
27	MES	17:10-18:12	Class 2 flare reported in this region. Drift E.
	MES	18:16-19:01	Spot in West.
	MES	19:04-20:15	Frames 2300, 2303, 2304 removed. Sub Flares throughout the day at 19:30, 21:00, 21:30 in W. portion Small flare in E. portion at 23:40
	SHG	20:51-21:30	
	MES	21:50-23:18	
	MES	23:41-00:58	
	MES	01:09-01:20	
	28	MES	15:44-16:40
MES		16:43-17:52	
MES		17:55-19:08	
29	MES	15:50-16:49	Same large group now in SW. Slight NS drift.
	MES	16:52-17:49	Slight EW drift
	MES	17:56-18:54	
	MES	18:57-19:27	Change to 28cm Slight drift to N. Image + tank repositioning
	MES	21:13-22:50	
	MES	22:55-23:44	
	MES	23:47-00:42	

Date	Type of Data	Time	Comments
July 30	MES	16:12-17:17	SW region. 1 min. interval
	MES	17:21-18:31	Slight E-W drift
	MES	18:36-19:30	
	MES	19:47-20:20	operating with 28cm
	MES	20:23-21:04	
	MES	21:05-21:29	interval now 2 min.
	MES	21:31-22:31	
	MES	22:34-23:28	
	MES	23:40-00:48	
31	MES	17:50-20:28	SW region (Limb)
	MES	20:31-21:35	
August 1	MES	17:12-17:18	SW Limb
	MES	17:22-17:32	Central region
	SHG	20:24-20:53	Central region
	SHG	20:57-21:56	SW Limb
	SHG	21:59-22:54	Central region
August 2	MES	15:31-16:26	Group near meridian to N.
	MES	16:29-17:27	slight drift to N.
	MES	17:45-18:47	Change to 28cm, same reg
	MES	18:50-19:41	
	SHG	21:32-21:55	Many blank frames due to loss of camera vac.
	MES	22:06-23:09	On 61cm
	MES	23:13-00:15	
	MES	00:19-01:12	
3	MES	15:34-16:52	Same group-now in NW
	MES	16:55-17:57	
	MES	18:00-19:39	
	SHG	20:47-21:21	
	MES	21:44-23:07	15 sec interval Region at E Limb Later change to 1 min. interval Includes prom. in early frames.
4	MES	15:27-16:11	Group in NW
	MES	16:36-16:43	Group in center switch to 28 cm
	MES	16:45-17:28	Group in SE
	MES	17:40-19:37	Back on 61cm same group.
	SHG	20:32-20:54	Scan-E region. Frames 279 & 280 removed.
	SHG	20:56-21:09	Scan - W region.
	MES	21:41-22:52	region in SE, NE drift
	MES	22:55-00:38	

Date	Type of Data	Time	Comments
August 5	MES	15:26-16:18	Region in SE slight EW drift
	MES	16:24-17:04	
	MES	17:09-17:13	Tracking stopped due to power outage
	MES	17:41-18:19	
	MES	18:30-19:35	
	SHG	20:17-20:34	E-region
	MES	21:32-22:47	
	MES	22:52-00:19	
	MES	00:22-00:51	
6	MES	15:35-16:37	SE region
	MES	16:40-17:38	Some NS drift
	MES	17:42-18:24	
	MES	18:28-19:28	
	MES	19:31-19:50	
	SHG	20:35-20:53	Negatives thin due to clouds. #366 and 367 removed. E region.
	MES	21:03-21:54	
7	MES	22:12-22:55	
	MES	15:23-15:27	SW region. Paused to set guider
	MES	15:34-16:22	
	MES	16:28-18:11	
	MES	18:15-18:55	
	SHG	23:46-23:57	Frames 398, 399 removed
8	MES	15:45-16:28	Group in SW region
	MES	16:33-17:29	Some EW drift
	MES	17:34-18:33	
	SHG	21:16-22:54	Frames 427 & 430 region
9	MES	15:38-16:21	Group in SW region
	MES	16:25-17:27	
	MES	17:30-18:34	
	MES	18:45-19:39	
	SHG	20:25-20:43	Frames 473 and 476 removed. Date reads 8/8/81 on SHG frames
	MES	20:54-22:12	Now on circular monopole in central region. Slight NS drift.
	MES	22:16-23:13	
	MES	23:15-00:28	
	MES	00:30-01:34	
10	MES	15:45-16:40	Group in SW 2 minute interval
	MES	16:44-18:21	1 minute intervals
	MES	18:24-19:40	2 minute intervals
	SHG	20:13-20:33	Frames 519 & 520 removed. Frames 509-517 mostly blank
	MES	21:06-22:04	Now on monopolar spot in NW.
	MES	22:15-22:17	
	MES	22:24-23:26	
	MES	23:29-00:08	

Date	Type of Data	Time	Comments
August 11	MES	16:04-16:49	Group near SW Limb. 2 minute intervals
	MES	16:52-18:11	1 minute intervals
	MES	18:19-19:33	
	SHG	20:20-20:54	Frames 547 & 549 removed.
	MES	21:02-22:07	Now on monopole spot in NW
	MES	22:10-23:01	
	MES	23:08-23:11	Now on E Limb Prominence
	MES	23:31-00:30	Back to monopole spot in NW
12	MES	00:33-01:00	
	MES	17:21-18:16	Group near SW Limb. 2 minute intervals
	MES	18:19-19:01	
	SHG	19:34-20:19	
	MES	20:30-21:51	Now on new spot group in the SW. 1 min. intervals.
	MES	17:21-18:16	Group near SW Limb. 2 min intervals
	MES	18:19-19:01	
	SHG	19:34-20:19	
	MES	20:30-21:51	Now on new spot group in the SW. 1 minute intervals
	MES	22:10-23:00	
	MES	23:01-00:09	
13	MES	16:27-18:15	Large group in SE.
	MES	18:18-19:33	
	SHG	20:00-20:47	
	MES	20:56-22:21	Slight NS drift
	MES	22:24-23:13	
	MES	23:15-23:47	
14	SHG	20:59-23:47	Many blank frames E region
16	SHG	18:03-21:11	E-SF region some blank and incomplete
17	SHG	18:15-20:03	
19	SHG	18:23-22:43	Frames 926 to 938 not recorded. on film.
20	SHG	16:13-17:25	Guider on SW region 1 minute intervals
	MES	18:02-18:34	SW region 1 min intervals
	MES	18:38-19:05	
	MES	19:08-00:01	
	MES	00:13-01:09	
21	MES	16:15-17:17	1 minute intervals region in SW
	SHG	19:29-00:34	SW- W Limb.

Date	Type of Data	Time	Comments
August 22	MES	16:45-16:47	WL cover on prior to this time.
	MES	16:49-17:51	SW region.
	MES	17:54-19:19	
	MES	19:21-20:31	
August 23	MES	15:57-16:36	begin 2 minute intervals at 16:04. SW
	MES	17:29-18:12	1 minute intervals
	MES	21:38-00:44	
August 24	MES	16:09-16:30	SW region, same as yesterday
	MES	19:23-20:55	
	MES	20:59-22:14	
August 25	SHG	19:37-20:45	Region 1 including West
	SHG	20:48-21:39	Region 2. Calibration scan incomplete
	MES	21:52-22:59	Same SW region
	MES	23:04-23:09	Change to 2 minute intervals
August 26	SHG	19:11-20:05	Region 1, central to East.
	SHG	20:19-23:19	Region 2, Central to west.
August 27	SHG	19:50-21:59	Region-central to east
	MES	23:01-00:18	Region along SE Limb. 2 min. intervals
August 29	SHG	23:42-01:02	Region - central to SE. Last frame 1396
August 30	SHG	15:42-17:16	5 minute intervals, Region - central to SE
August 31	SHG	18:26-01:13	Inner Channel - frames appear off line a little. Outer channel ok- Region central.
Sept. 1	SHG	22:05-00:46	Both channels: later frames become thin
2	SHG	16:34-18:40	Last standby at #1621. Later frames of less density.
3	SHG	20:16-00:00	
	SHG	17:24-23:30	Region 1 included W-Limb. Region 2 included E-Limb.
5	SHG	17:22-18:13	Many frames partially to completely obscured by clouds.
	SHG	18:34-21:23	
7	SHG	17:16-21:28	
8	MES	18:22-19:40	2 minute intervals to end of run.
9	MES	17:18-	End of run not logged.
	SHG	23:42-01:00	Some WLT damage on Inner Ch. at start.

Date		Type of Data	Time	Comments
Sept.	10	SHG	18:05-23:10	Frames 2071 to 2081 will show 9 Sept.81
	11	SHG	18:39-00:42	
	12	SHG	17:28-00:43	
	14	MES	16:52-18:52	
		SHG	19:31-01:16	Poor seeing, observing SW region, 2 min interval. Later frames under exp. Region in the East.
	15	MES	18:19-20:19	Central region. Last MES for 1981
		SHG	20:51-00:34	Many poor frames due to clouds and WLT damage.
	16	SHG	18:30-00:50	All frames appear quite thin. Inner channel off line somewhat.
	17	SHG	17:49-23:55	All frames quite thin due to clouds
	18	SHG	18:39-01:10	All frames appear to be off line core. Last frame - 195 calibration. Many no film advance.
	19	SHG	17:39-01:00	Inner channel frames slightly thin. Blank frames - 396, 397, 422, & 444. Calibration at 0445 & 0486. Many blank frames. Calibration at 0508 All frames are quite thin. Later frames off line.
	20	SHG	16:25-21:38	
	21	SHG	16:12-00:15	
	22	SHG	16:24-23:30	
	23	SHG	22:51-01:10	All frames very thin. Blank frames - 554 to 556. No calibration apparently due to clouds.
	25	SHG	17:00-00:45	Frames 588 & 649 blank. Later frames become thin but appear to be on line.
	26	SHG	17:24-00:27	Frames 0698 & 0760 blank. Later frames much thinner.
	27	SHG	17:19-20:39	Region 1 west to central.
		SHG	20:47-22:58	Region 2 central to East. Many NFA. Frames 847-852 blank.
	28	SHG	17:01-20:17	Outer channel: Frames 877 to 897 fogged 898 to 903 very thin on both channels.
Oct.	6	SHG	18:11-23:36	Frames 969-975 blank.
	9	SHG	18:53-19:09	Region including E. Limb. 2 min. int. Region including W. Limb. Region including East, sub flare-2306 After frame 1030 all frames become thin to blank.
		SHG	19:13-20:40	
		SHG	23:06-23:40	
		SHG	22:10-22:12	
	14	SHG	22:21-22:29	Primary region in the center
		SHG	22:29-23:45	Secondary region including E. limb.
	15	SHG	18:00-18:16	Back to primary region.
		SHG	18:21-19:15	Region 1 including E limb Region 2 - western group.
	16	SHG	19:16-19:23	Region 1 including W. limb and western group. Region 2 E. limb and Eastern group. No guider. Region 1, Guider on Region 2, no guider
		SHG	19:25-19:31	
		SHG	19:34-29:37	
		SHG	21:40-23:08	

Table 2

1981 Mg I Flares

Hale region	1981 date	UT	Mg I import	10 cm width	10 cm pk SFU/UT	GOES 1-8A 0.5-4A	X-ray hard.	H α import	HXRBS peak CPS/UT
17705	23	1730	none	10 ^m	1550/1735	1.2-5 1.5-6	0.13	SN-SB	
705	June 25	2200	5	1 ^m	385/2202	5E-5 1E-5	0.2	2B	77/21:58:00
	7	probably none, flare misreported.							
	July								
748	22	1827 -1937	.5	3 ^m	30/1836	8E-6 7E-7	0.09	1B	75/19:05:40
760	26	1810	.2	3 ^m	75/1811	1.5-5 2E-6	0.13	-	
760	26	2134	3	3 ^m	130/2131	9E-5 3E-5	0.33	-	222/21:34:10
760	26	2331	2	2 ^m	15/2328	1.1-5 1.2-6	0.11	-	345/23:27:45
760	26	2350	2	1 ^m	22/2348	1.5-5 2E-6	0.13	SN	292/23:49:10
760	27	1725	10	4x1 ^m	350/1725	1.5-4 4E-5	0.27	SF-1B	
760	30	1624	.5	2.5 ^m	230/1617	1.2-5 1.7-6	0.14	SN	388/16:17:00
760	30	2350	5	1 ^m	130/2344	4.3-5 1E-5	0.23	1N-2B	403/23:25:45